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Fabrication and dielectric properties of $BaTi_{0.96}Ca_{0.04}O_{2.96}$–$BiZn_{0.5}Ti_{0.5}O_3$ X9R $BaTiO_3$ based ceramics

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In recent decades, $BaTiO_3$ (BT) has been the most successfully commercialized dielectric material for XnR (n=7,8,9) capacitors satisfying the capacitance variation below ±15% over temperature ranges of -55 °C ~125 °C, 150 °C, 200 °C, respectively. Many efforts have been made to optimize the dielectric properties of BT, such as forming solid solution with $BiMeO_3$, which is relaxor with diffused dielectric peaks and exhibits a plateau ε-T curve above T_m.

In this work, $BaTi_{1-x}Ca_xO_{3-x}$ (BTC100x) ceramics were synthesized via solid-state reaction method, where the Ca substituting Ti site was confirmed by the XRD, TEM analyses and (Vienna Ab-initio Simulation Package) VASP calculation. The BTC4 ceramics exhibited enhanced dielectric constant at low temperature, as shown in Figure 1, which may greatly improve the dielectric constant stability at lower temperature when forming solid solutions with $BiZn_{0.5}Ti_{0.5}O_3$(BZT) end member. The phase structures, microstructures and dielectric properties of (1-y)BTC4-yBZT ceramics were systematically investigated. The pseudocubic perovskite structure was formed in (1-y)BTC4-yBZT ceramics, the solubility limit of which was around 0.13~0.15. The simultaneous incorporation of Bi^{3+} and Zn^{2+} to occupy A and B sites in the BTC4 lattice induced diffused phase transition which greatly improved dielectric temperature stability over a wide temperature range, as depicted in Figure 2. Of particular significance is that the 0.85BTC4-0.15BZT ceramic is found to exhibit flat dielectric behavior with capacitance variation being less than ±15% over the temperature range of -55 °C to 200 °C, which meets the requirement of X9R capacitor specification.

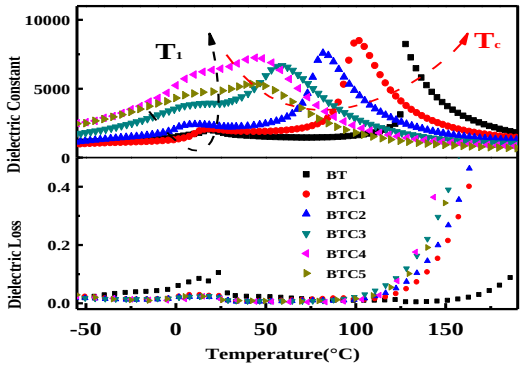

Figure 1. The plot of dielectric constant as the function of temperature of BTC100x ceramics.

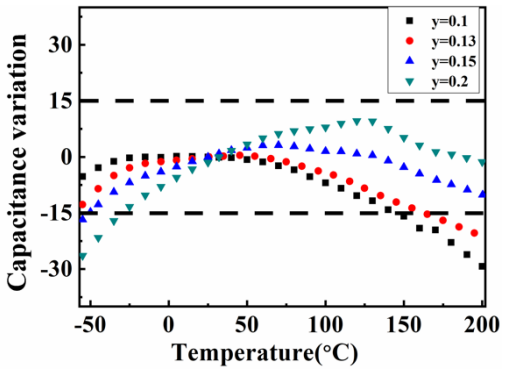

Figure 2. Capacitance variation as a function of temperature for (1-y)BTC4-yBZT ceramics.

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